Report No. SS11-03

April 4, 2011
File No. 3420

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From: Forest Health Protection, South Sierra Shared Service Area

Re: Options and considerations for Snag Creation on the 2011 2Chaix and Tobacco Projects, Georgetown Ranger District, Eldorado National Forest

The Georgetown Ranger District is proposing to thin two areas (2Chaix and Tobacco) with the objectives to increase forest resilience by improving stand vigor and resistance to disease and insect mortality, and restore portions of forest vegetation to the composition of tree species and size classes that are likely to be more sustainable into the future. In addition, they would like to improve wildlife habitat by increasing the number of useable snags. Snags or wildlife trees would be artificially created in specific units of both projects. This report discusses observations conducted in 2009, 2010, and early 2011, as well as options and considerations regarding snag creation.

STAND INFORMATION

2Chaix Project

This project is located between Big X and Chaix Mountains on the southwestern edge of the Georgetown Ranger District, Eldorado National Forest (T11N, R12 E; T11N, R13 E; and T12N, R12 E); elevations range between 4,000-5,000 feet. Proposed treatments focus on reducing stand density in ponderosa pine plantations and mixed conifer natural stands. The natural stands have an average basal area (BA) of 210 ft^2/acre (stand density index (SDI) of 327), and 180 trees/acre. Historically stand compositions were dominated by ponderosa pine/Douglas-fir with a lesser component of incense cedar, sugar pine, white fir, madrone and black oak. Most of the current understory is now dominated by white fir and incense cedar and tan oak. Trees and brush under the oaks and mature conifers trees are planned for removal out to drip line to improve vigor and reduce ladder fuels. Proposed treatments are to reduce stands to 120-180ft^2/acre, retaining all trees greater than 20 inches. The plantations are dominated by ponderosa pine established after the Camp 7 fire (~50 years old). Diameters range from 9 to 22 inches with a stand average of 165 ft^2/acre BA and165 trees/acre. The understory is occupied by additional trees that have seeded into plantations, green leaf manzanita, and *Ceanothus* sp. Thinning treatments were initiated for some plantations in 2Chaix starting in 2008; desired residual tree spacing was 20 feet x 20 feet (~140 ft^2/acre BA).

Tobacco Gulch Project
Most of the proposed project units are located on along Darling Ridge, west of Bald Mountain lookout (T12N, R11E) with a few units in T13N R11E, Sections 32-33; elevations range from 3,000-4,500 feet. Units are scattered within a popular recreation area (Rock Creek) and surrounded by multiple private landowners. The entire area is a Defense Fire Protection Zone and has been managed for roadside fuel reductions due to proximity with residential housing. Evenly mixed conifer pine type (ponderosa pine, sugar pine, Douglas-fir, and incense cedar) comprise the natural stands; black oak, tanoak, and madrone trees also add to stand diversity. Oaks and ponderosa pine regenerate well in the understory. Natural stands average 258 ft^2/acre BA (SDI 454; 380 trees/acre). A prescribed fire (stretching from unit 303-34 to 302-28) was implemented during the fall of 2010 that appears to have met management objectives.

Plantation trees within the project are 25 or 50 years old. The younger plantations (ex: unit 303-38, 39, 40) have not been treated, while the older plantations have been pre-commercially thinned at least twice followed by prescribed burning. Young plantation stands have 277 ft^2/acre BA (SDI of 395;165 trees per acre; average 10 inches DBH).

BARK BEETLES: CURRENT CONDITIONS

The biggest concern with some methods of artificially creating snag/wildlife trees is subsequent bark beetle activity which can result in additional tree mortality. Western pine beetle (*Dendroctonus brevicomis*, WPB) is the most destructive bark beetle of ponderosa pines in the state and highly attracted to weakened, dying or stressed trees, and often kills trees in small groups (Wood et al., 2003). Drought events in California increase host susceptibility, triggering outbreaks that can result large groups of mortality. Fir Engraver (*Scolytus ventralis*) activity is also strongly correlated with drought events, in addition to being active in diseased trees. A buildup of mountain pine beetle (*Dendroctonus ponderosae*) populations within the project areas should be somewhat limited by the small amount of host component; however mountain pine beetles can be highly attracted to fire-injured sugar pines which should be taken into consideration when planning prescribed fires. Insects associated with Douglas-fir or incense cedar are typically not as aggressive and do not cause extensive mortality.

Western pine beetle has been very active in various locations throughout the Eldorado National Forest, primarily in older ponderosa pine plantations where average tree diameters exceed 13 inches. Within the 2Chaix project boundaries, about 50 acres (12-26 inches DBH, mostly small acre group kills) of untreated and recently thinned have been attacked by WPB (Forest Health Monitoring, Aerial Detection Surveys 2008, 2009, 2010 and FHP ground surveys 2009). Western pine beetles have caused mortality in both untreated and recently treated stands. Group kills within 2Chaix have impacted more trees per acre (20-40 trees/acre) compared to areas around Tobacco Gulch (6 trees/3 acre). One of the largest groups in 2Chaix contained 55 successfully attacked trees in 2009 within a 2 acre patch. For the Tobacco Gulch and 2Chaix project areas, average SDI is close to or exceeds the bark beetle limiting SDI of 365 for ponderosa pine determined by Oliver (1995); therefore, the extent and amount if western pine beetle-caused tree mortality is not surprising. The diversity of trees species within Tobacco Gulch may slightly buffer attraction for beetles, but if resource competition and growing space are limited, vigor and attack resistance will be affected.

While small group kills are be beneficial to promoting snag creation and disturbance in the landscape, current WPB activity in the Eldorado is recognized as incipient epidemic –groups kills that are beginning to coalesce in the area and beetle populations building over a short timeframe (Schmid et al. 2007). The number of groups and trees killed per group identified within the boundaries of the project area suggest future losses from WPB that would be above target snag levels.

DESIRED SNAG CONDITIONS

While the primary purpose and need for both projects are to "increase forest resilience by improving stand vigor and resistance to disease and insect mortality" and "reducing wildfire intensity by changing existing fuel profiles", snag/wildlife tree creation falls under objectives to restore forest structure that resembles historic conditions and is sustainable for all components of forest ecosystems. General desired conditions are to implement management treatments that project young stands towards old forest characteristics where habitat is suitable and sustainable for wildlife populations to thrive.

Overall, current snag levels are considered low (less than 1 >15 inch standing dead trees) in both project areas which half of the units are mature plantations. Small trees (less than 15 inches) are useful to some species but most cavity-nesting birds prefer larger diameters that have internal rots or old wounds. Ponderosa pines and Douglas-fir ranging from 16 to 20 inches DBH are preferred for snag creation, as well as clumping snags in small groups rather than scattered individual trees. Incense cedars do not make good habitat for cavity nesters and therefore would not be a preferred for artificial snag creation. Some areas of the natural stand units in Tobacco Gulch were estimated by the wildlife biologist to have greater wildlife tree counts than <1 per acre with the higher abundance of hardwoods. During a field visit in February 2011, newly fallen trees and snags were noted (created by recent storms of heavy wet snow and high winds) that were not identified during earlier exams so additional scouting should be conducted to determine what the existing snag level compared to the desired level. Snag levels have apparently increased in stands since plot exams were done 2-3 years prior to this report.

Snag Creation Alternatives

Snags are a natural component of forest ecosystems and provide a variety of functions and values to forests and wildlife species that occupy them. Snags and logs may be utilized at multiple phases of decomposition by wildlife for activities such as foraging, nesting, roosting, and/or denning. Live trees are also utilized; especially if unique structural or biological characteristics make them favorable to wildlife (e.g. trees with dead or snapped tops used as nesting sites by large birds). Some forest landscapes are thought to be "snag deficit" for wildlife needs because of the direct action of forest managers or because of natural events such as winter storms or fire (Shea et al. 2002). Many current forest management plans stipulate the desired number of snags/acre, and snag size (DBH) and height, which should be residual on the landscape. However, a one-size-fits-all guideline is likely unwise as the snag resource is highly dynamic, both in space and time, the capability of different sites to produce and sustain snags is highly variable, and the number of large trees/acre, their life span and how long they remain upright, needs to be examined at both the landscape and project scale.

Snags can be created naturally through a variety of processes including successful attack by bark beetles, wildfire, pathogens, and storm events. Snags can also be created through artificial means that tend to mimic natural processes. Prior to artificially creating snags, some thought should be given as to their desired purpose and wildlife species of interest. Foraging woodpeckers tend to select trees and snags containing high levels of bark and woodboring insects, whereas nesting woodpeckers generally require pockets of older, decayed wood that permit nest excavation (Farris et al. 2002). • Foraging activities by woodpeckers during the first few years of snag's life may influence subsequent decompositions of sapwood by promoting decay organisms associated with nest cavity excavation. Thus, nest excavation is more likely on snags that have an extensive history of foraging activity (Farris and Zack 2005 GTR-198). In addition, tree species, size, and height, may make a difference in many forest types. In a study conducted in the eastside pine type in northeastern California, Laudenslayer (2002) found no nest holes in California black oak, incense cedar, lodgepole pine, red fir or western juniper snags on any of his plots. In

utilized species (white fir, Jeffrey pine, ponderosa pine) he found that nest holes were typically in trees >15 inches DBH and in excess of 65 feet tall.

Less understood than the actual methods of snag creation are the decline and decay process, and their sequence. The invasion sequence likely has a strong influence on how quickly a tree dies, how long the resulting snags stand erect, and those characteristics affecting its suitability and acceptability for use by wildlife (Shea et al. 2002).

<u>Snag Creation</u>

Lewis (1998) summarized several techniques used for creating snags and wildlife trees[1]:

- *Topping*: The terminal is either sawed or blasted off.
- *Limbing*: Branches and large limbs are removed.
- *Cavity construction*: Holes are artificially created in trees.
- *Girdling*: Trees are girdled at the base to prevent water and nutrient flow.
- *Fungal Inoculation*: Heart rots are artificially inoculated into trees to initiate internal decomposition.
- *Pheromones*: Synthetic chemicals that mimic natural bark beetle attraction signals are used to "bait" trees for attack.

In addition to these methods described by Lewis (1998), intense burning around the base of trees (Conklin et al. 1991) and the use of herbicides (Bull and Partridge 1986) have also been used for snag creation, and often multiple methods are implemented on a given tree (e.g. topping and limbing). A site-specific field evaluation should be conducted prior to using methods that have the potential to incite additional tree mortality (e.g. wounding green trees, application of bark beetle pheromones).

Topping: topping trees via chainsaw, or blasting with dynamite, to create a wound site for natural inoculation by pathogens has been shown to be successful. Snag topping has been conducted previously in California on many forests including the Modoc and Plumas National Forests (via smoke jumper crews) and at Yosemite National Park. It is unknown how topping may have affected snag life or if cavity nesting species responded to the artificially topped trees (Laudenslayer, 2002). Nesting woodpeckers tended to prefer topped trees versus girdled trees in Washington (Hallett and others 2001), while Parks and others (1999) documented greater nest use in mechanically girdled snags versus trees killed using basal burning methods, or a combination of girdling and burning. In a summary of woodpecker and snag interactions by Farris and Zack (2005) woodpeckers used trees killed by beetles 1-8 years after death, foraged in these trees 1-3 years after their death and nesting in them >5years after their death (GTR-198). Trees killed by bark beetles alone, or in association with fire serve as high quality foraging habitat and seem most likely to contain future nest cavities. In terms of foraging, woodpecker utilization of snags appears to be most concentrated within the first three years of tree death, especially on snags originating from bark-beetles and/or a combination of bark beetles and low/moderate severity fires. Snags created artificially through girdling or topping are used less intensively for foraging. Moreover, peak foraging activity in artificially snags typically occurs after the first two or three years of snag creation. This disparity is likely due to differences in the sequence of insect infestation. Greater insect diversity and abundance have been reported in naturally created snags compared to snags created artificially by girdling (Shea and others 2002). Due to different decay rates for snag creation methods, cavities were usable in burned areas 2-3 years following fire, 5 years following

[1] Wildlife trees are standing living trees that are providing current habitat of wildlife, rather than snags that are completely dead.

bark beetle attack and 6-8 years following girdling. On ponderosa pines in Oregon, Bull and Partridge (1986) reported 82% of trees topped with a chainsaw and 61% of trees blasted dynamite had woodpecker feeding activity within 3 years of the treatment. In fact, in their study, topped trees were more frequently used for foraging compared to all other snag creation methods they tried. Topped trees also had a higher amount of excavation compared to other methods.

Limbing: limbing creates additional wound sites for natural inoculation by pathogens and often coincides with topping. Little information is available regarding if this method increases wildlife use directly, however creating multiple wound sites would likely decrease the time for decay organisms to become established. Limbing is typically combined with topping and/or cavity construction.

Cavity construction: excavating holes with a chainsaw may increase the habitat value to wildlife (Carey and Gill 1983), but may also cause premature snag breakage at the cavity sites (Carey and Sanderson 1981). Lewis (1998) stated that cavity creation can be costly but is typically less expensive when combined with topping.

Girdling: typically 2 chainsaw cuts are made around the entire bole about 8 inches apart somewhere between 2-5 feet up from the ground. In addition, bark and phloem are often removed in between the chainsaw cuts. Tree death tends to be quite slow with girdling; some studies have shown that it can take up to 2 years + for girdled trees to fade and that girdling may increase a tree's susceptibility to windthrow. Authors have reported mixed results regarding wildlife use of girdled trees. Shea and others (2002) reported no cavities in ponderosa pines 3 years after trees had been girdled, but some of the girdled trees did have evidence of woodpecker feeding. Bull and Partridge (1986) reported 53% of the girdled ponderosa pines in their study had evidence of woodpecker feeding.

Fungal Inoculation: holes are bored into the heartwood and heart rotting fungi are placed in the holes via an infected wooden dowel or agar culture. Depending on tree species of interest, this method has shown promise in creating areas of heart rot that are conducive to excavation.

Pheromones: many bark beetle pheromones are now synthetically produced for use in forest management activities. For most of the pine bark beetles in California products are available that can be attached to trees to incite attack by bark beetles. There are not synthetic pheromones available for fir engraver beetle, the primary killer of white and red fir. Pheromone packets are placed on the tree of interest during the beetle flight period and numbers of attacks are closely monitored. When attacks reach a certain number the pheromone packet is removed to decrease the likelihood of beetles attacking surrounding trees. This method has been used successfully in California and Oregon to create ponderosa pine snags with no spill-over into surrounding trees.

Shea and others (2002) reported higher levels of wood pecker drilling and cavity construction in bark beetle-baited trees vs. girdled trees while Bull and Partridge (1986) reported similar levels of woodpecker drilling between bark beetle-baited trees and girdled trees.

The success associated with killing trees using bark beetle pheromones relies on many factors. There needs to be a source of beetles in the area, the tree needs to be suitable host material, and the tree(s) needs to be readily accessible for frequent monitoring of bark beetle attacks. An on-the-ground assessment of the site would be required to determine levels of current activity by bark beetles which would give an indication if there are enough beetles in the area to successfully attack a tree or so many beetles that the likelihood of spill over into surrounding trees would be high.

Baiting with bark beetle pheromones would be the safest and likely the cheapest method available for creating snags. It doesn't require any tree climbing or other types of tree manipulation (e.g using a chainsaw).

Prescribed burning or Burning around the base: burning around the base by piling up slash and igniting with a drip torch has been used in New Mexico with the dual purpose of killing trees heavily infested with dwarf mistletoe and retaining the trees on site as snags. Drill holes were observed on nearly all of the sample trees three years after treatment (Conklin et al. 1991).

As with pheromones, prescribed burning needs to evaluate local bark beetle activity, suitability of host material that will be affected by treatments. It is guaranteed that bark and woodboring beetles will appear if host material is burned to the point of death. According to Hessburg et al (2010), burning in the spring significantly increases bark beetle activity, even doubling in areas thinned and underburned. However, attacks may not necessarily translate into growing infestation centers if other conditions are not conducive to promoting population increase.

Herbicides: this is commonly known as the "hack and squirt" method. Cuts are made at the base of the tree with an axe and then an herbicide in applied into the cut. This way of killing trees is most commonly used for bark beetle research to create a stressed tree that is in turn attacked by bark beetles, which can then be used for a variety of investigations from beetle biology to pesticide trials. Little information is available regarding using herbicides to create snags and subsequent wildlife use. Bull and Partridge (1986) did include herbicides as a treatment in their snag creation study and found that herbicide-treated trees tended to fall sooner than other treatments; 25% of the herbicide treated trees fell within 5 years post-treatment. In addition, they found herbicide-treated trees had the lowest amount of feeding activity by woodpeckers. Information on this method for creating snags is sparse so other methods listed above would likely be preferred.

DISCUSSION OF SNAG/WILDLIFE TREE DEVELOPMENT IN PROPOSED PROJECTS

Based on the current versus desired number of snags or wildlife trees, the 2Chaix project area is deficit, and wildlife species would likely benefit from an increase in the number of snags on the landscape. However, based on recent western pine beetle activity in these plantations over the past three years, creation of snags by baiting trees with synthetic bark beetle pheromones in this project area would only be advisable if implemented during a time when environmental conditions would be low risk for subsequent beetle attack. We recommend that snag creation be postponed until stand density is reduced and precipitation conditions are at or above normal.

Untreated stands in Tobacco Gulch are still susceptible to attack by western pine beetle even though most proposed units and some adjacent areas have already been treated (thinned and burned). The high species diversity and percent species composition, combined with the varied age classes in the natural stands and older plantations would tend to reduce the likelihood of high mortality levels overall; however, susceptibility to pine bark and engraver beetles in the remaining dense patches in the units and in the unthinned plantations remains higher due to stand density. If beetle activity continues as it has for the past three years, tree mortality levels are still expected to be above normal within areas deemed high risk.

Artificial augmentation of snags/wildlife trees in Tobacco Gulch should also take into account existing stem decay agents. *Phellinus pini* conks were noted in a 10 inch DBH Douglas-fir in unit 302-28. *P. pini* is a white pocket rot that is most often found in California on Douglas-fir and occasionally on pines and true firs. This rot affects both heartwood and sapwood, degrading early wood rather than late wood. Identified infected Douglas-fir can be retained on site rather than removed or new snags created. This

pathogen moves very slowly through a stand, that high levels of future infection are not expected to suddenly increase with or without treatments. This pathogen is actually promoted in other regions for its slow decay and assistance in cavity habitat creation. No other units were observed with *P. pini*.

Summary

Land managers should consider a number of factors when selecting a method for creating snags. The potential method should have a high probability that the resulting snags are suitable and acceptable (tree size, height, species, location, etc.) to the wildlife species of concern. Duration of the snag is also important, as many studies have shown that certain methods of snag creation may lead to premature tree failure. Safety and economics are other considerations. Safety hazards should be thoroughly evaluated prior to implementing any treatment that requires tree climbing, chainsaw and/or dynamite use, and only certified personnel should be involved. Depending on the method chosen, timing of activities should also be considered to reduce the potential for tree mortality to go beyond the selected trees.

Please contact Forest Health Protection with any additional questions or concerns regarding snag creation. Additionally, our service area staff is available to provide technical support, competitive financial assistance, management or pest identification training, and NEPA documentation support regarding forest insect or disease-related issues.

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